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Thermodynamics

→ state the first law of thermodynamics (statement).
→ proofs.
→ solve examples.

→ First law of thermodynamics

ΔE : change in internal energy (K.E + P.E)
ΔH : change in enthalpy (ΔE, q, work)
q : Heat

→ law of conservation of energy

- Work and Heat are both forms of energy.
- Any form of energy can be converted to another form.
- Energy can't be created nor destroyed.

→ Prof.

- If we have a system of Internal energy (E_i)
- If the system absorbs (Endothermic reaction and ΔH = +ve) quantity of Heat (q)
- Then the energy of system will be ($E_i + q$)
- If the system use some of it's energy to do work (w)
- Then final energy of system $E_f = E_i + q - w$

$$\therefore E_f - E_i = q - w$$

$$\therefore \boxed{\Delta E = q - w}$$

- Take into Consideration signs

q is : (+) when system absorbs heat.
(-) when system evolves heat.

w is : (+) when the work done by system.
(-) when the work done by system.

- at Constant Volume: (bomb calorimeter)

Hence, $V_1 = V_2$ so $\Delta V = 0$

$\therefore W = \text{Zero}$ as $(W = P\Delta V)$

$\Delta E = q_v \Rightarrow$ only per 1 mole

q_v : amount of heat evolved or absorbed at Const. Volume.

Note: Any heat q of Reaction at Const. Volume is represented by ΔE

ex comb. 5 gm of X at Const. Volume evolves 50 J. → calculate q_v, ΔE.

→ $q_v = -50$ J. (-ve as system evolves heat).

→ ΔE : If X is NaCl

5 gm → -50 J

1 mole → ?? $\underline{?? = \Delta E}$

58,5 gm → ??

Note: If the given is 5L turn it into grams.

→ AT const. Pressure

Note: All Reaction are made at const pressure.

$$w \neq \text{Zero}.$$
$$\Delta E = q_p - w.$$

q_p: amount of heat evolved or absorbed at const. pressure.

$$q_p = \Delta E + w. \quad = \Delta E + P\Delta V$$

∵ The thermodynamic function H.

$$H = E + PV$$
$$q_p = (E_2 - E_1) + PV_2 - PV_1$$
$$= (E_2 + PV_2) - (E_1 + PV_1)$$
$$\therefore q_p = H_2 - H_1$$
$$\therefore \boxed{q_p = \Delta H} \Rightarrow \text{per one mole.}$$

Note
1) one mole: ΔE, ΔH } Heat of Reaction.
more than one mole: q. }

2) at const. Volume: ΔE
at const. pressure: ΔH

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→ Heat of Reaction

explained by Note 1), 2).

- If V_A and V_B are the volumes of gases Reactants A and product B.

- If n_A and n_B no. of moles of gases Reactants A and products B

$$w = P \Delta V = P(V_2 - V_1)$$

$$; PV = nRT$$

$$w = n_2 RT - n_1 RT$$

$$; R, T ; \text{Consts}$$

$$w = (n_2 - n_1) RT$$

$$w = \Delta n RT$$

$$\therefore \Delta H = \Delta E + w$$

$$\therefore \boxed{\Delta H = \Delta E + \Delta n RT} \Rightarrow \text{gases only.}$$

Summary

→ ΔH: $\Delta H = \Delta E + \Delta n RT$

$$\Delta H = \Delta H_{f(P)} - \Delta H_{f(R)}$$

→ ΔE: $\Delta E = q - w$

$$\Delta E = q_v \rightarrow \text{per one mole.}$$

$$\Delta n = n_P - n_R \rightarrow \text{Gases only}$$

- To solve any problem:

1) write the equation (Reaction of system).
2) balance Reactants and Products.
3) Determine the type of material.

$$1A + 2B \longrightarrow 3C + 4D$$

Notes → The number of moles of A must be one mole as it is the basic Reactant which I follow.

→ ΔH_f (each element) = zero.

$$C_3H_{8(g)} + 5O_{2(g)} \longrightarrow 3CO_{2(g)} + 4H_2O_{(l)}$$

$$\Delta H = 3\Delta H_{f(CO_2)} + 4\Delta H_{f(H_2O)} - \Delta H_{f(C_3H_8)}$$

$$- \cancel{5\,\Delta H_{f(O_2)}} \quad \because \Delta H_{f(O_2)} = 0$$

→ Δn : Take into consideration if Reactant and Product are (solid, liquid or gas).

→ ΔH : Don't take into consideration (solid, liquid or gas) but element or compound.

→ Δn : could be (+ve, -ve or zero)

→ Δn : Solid or liquid = zero, but gas = ?? (value).

→ R = 8,314 Joule except for one case if $PV = nRT$